





Stealth SUSY

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SUSY 2011**

**Based on work with Matt Reece and Josh Ruderman
arXiv:1105.5135 [hep-ph], work in progress**

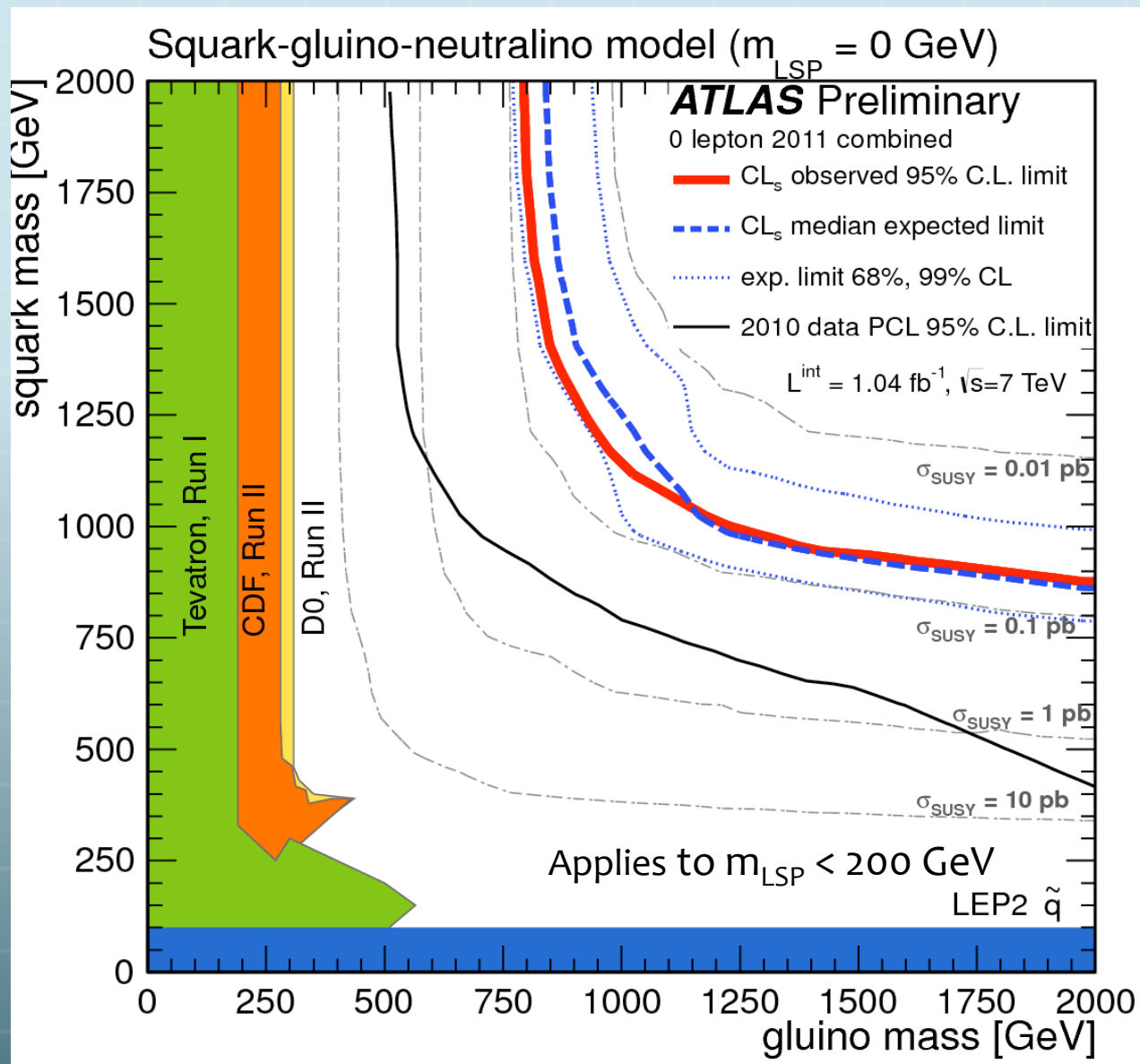
Outline

-  **Motivation**
-  **Mechanism**
-  **A simple example model**
-  **Spectrum and collider signals**



So far Jets+ MET search at the LHC has already placed strong limits on the colored MSSM superpartners in R-parity conserving scenarios

$M_{\text{gluino}} > 800 \text{ GeV}$ (with decoupled squark)



Taken from
Henri Bachacou,
Lepton-Photon 2011

SUSY variants



The bounds have several known exceptions:

R-parity violation, squeezed MSSM spectrum, long cascade decay chains



A simple and natural exception: SUSY without MET

No R-parity violation;

No artificial tuning: SUSY hides SUSY;



An electroweak scale hidden sector with a naturally squeezed spectrum (as a result of an approximate SUSY)

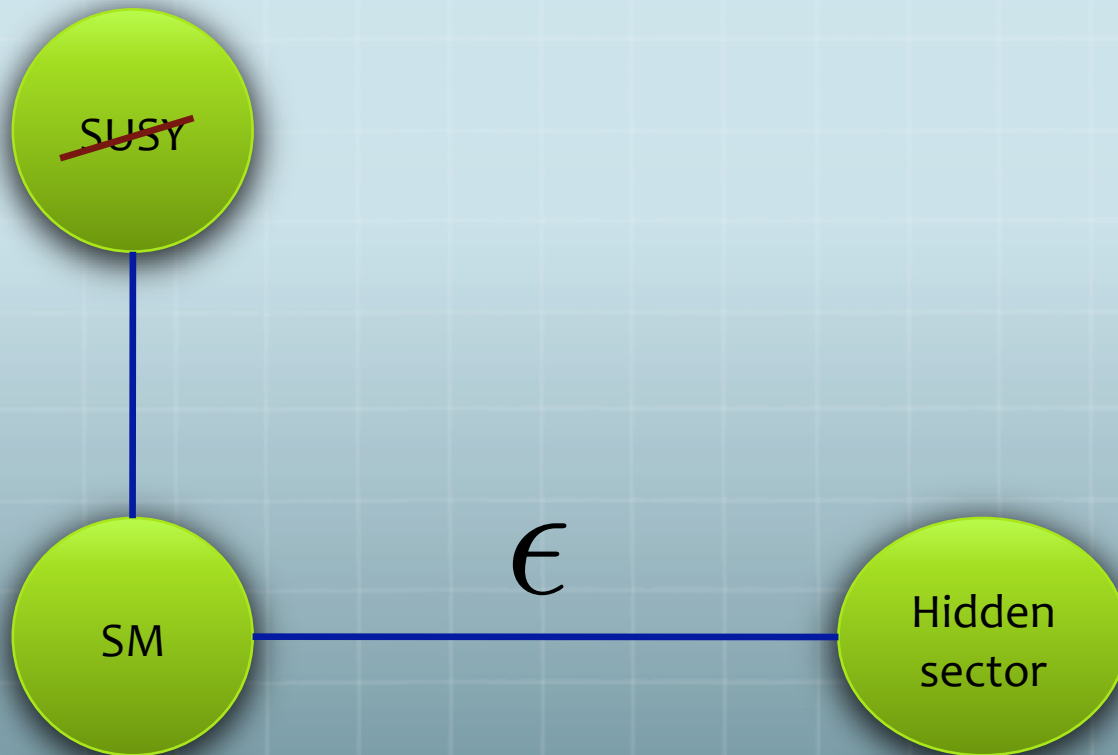
Different from MSSM with a squeezed spectrum (e.g., gluino mass close to bino mass, which requires tuning)



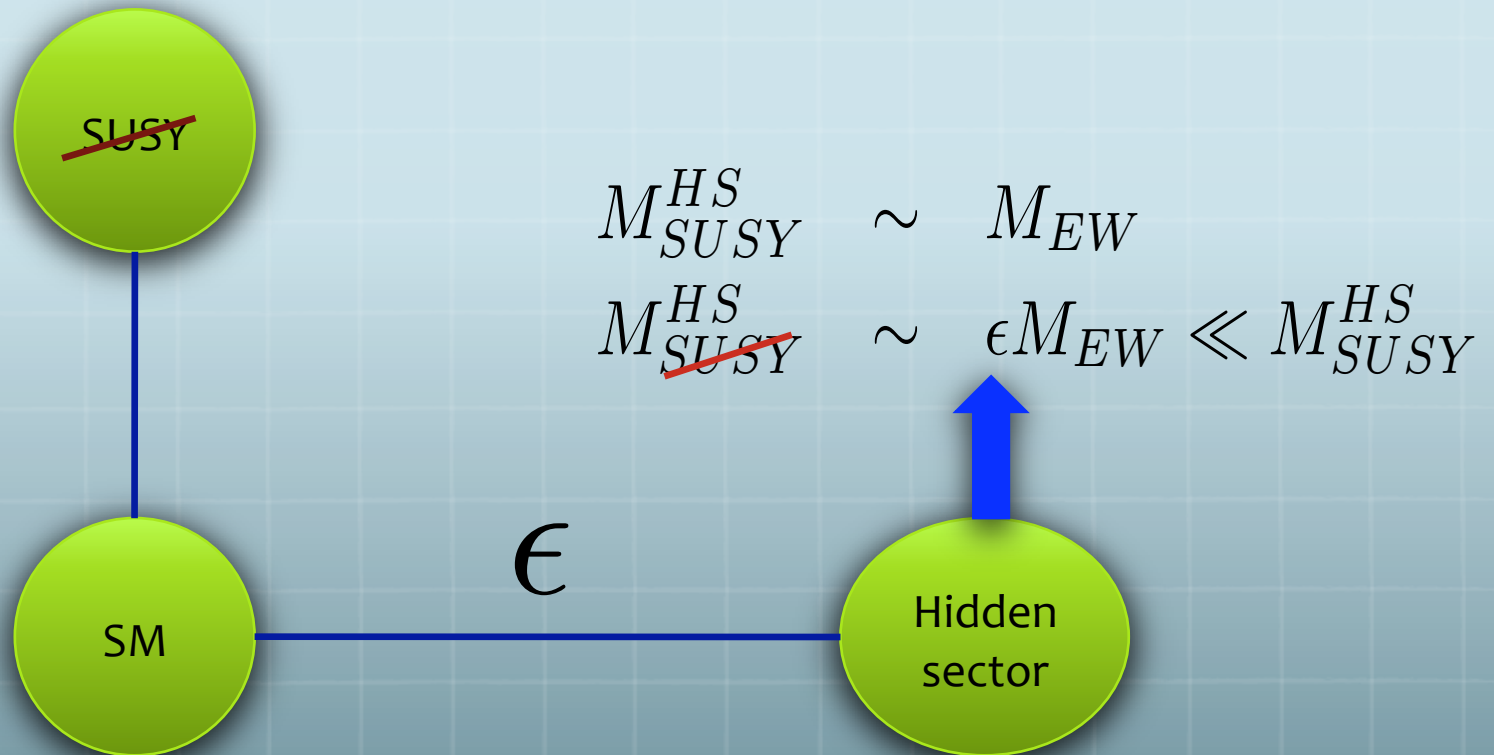
Simplest possibility: a chiral superfield S

many more theoretical possibilities: z' , vector-like confinement sector; compatible with different SUSY breaking mechanisms.

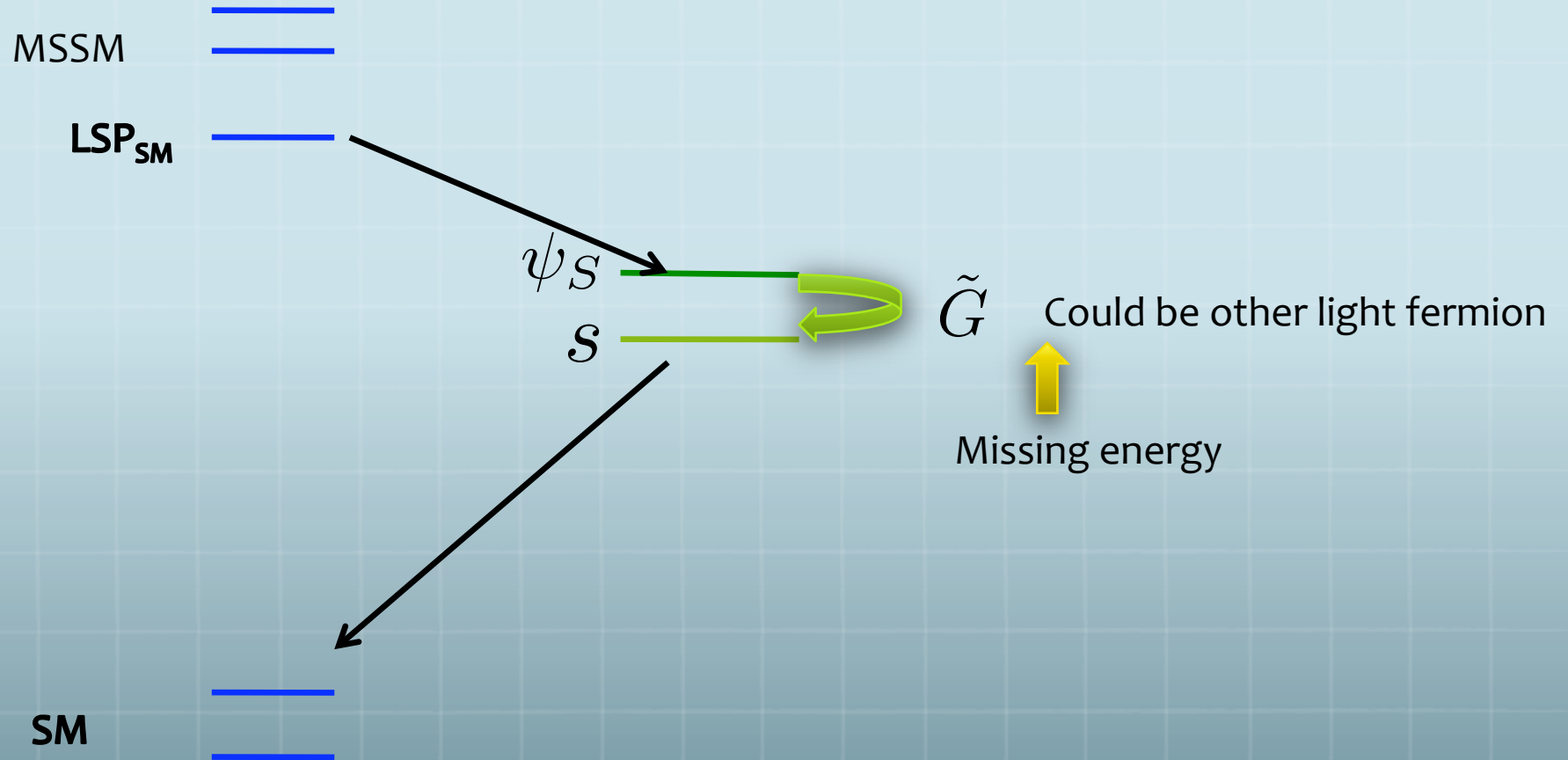
Mechanism

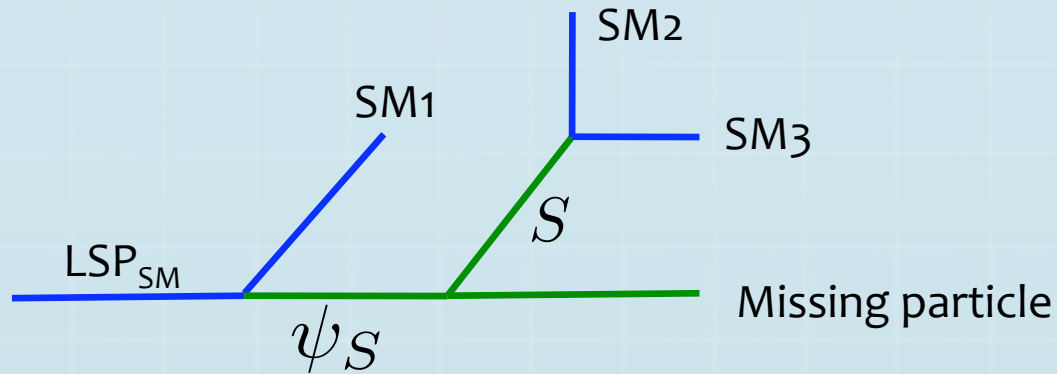


Mechanism



E.g., Low-scale gauge mediation with a singlet S





In the ψ_S rest frame,

$$E_{missing} = \frac{m_{\tilde{S}}^2 - m_S^2}{2m_{\tilde{S}}} \approx \delta m$$

Fermion mass Scalar mass

$$\delta m \equiv m_{\tilde{S}} - m_S$$

In the lab frame,

$$E_{missing} = \gamma \delta m \approx \frac{m_{LSP_{SM}}}{m_{\tilde{S}}} \delta m$$

$$\delta m \rightarrow 0, E_{missing} \rightarrow 0$$

An example model

🌐 **Portal:** $Y, \bar{Y} \quad 5 + \bar{5}$ under SM SU(5)

🌐 **Model:**

$$W = \lambda S Y \bar{Y} + m_S S^2 + m_Y^2 Y \bar{Y}$$

m_S is taken to be 100 GeV

🌐 **Soft mass of S is generated at one-loop (in gauge mediation)**


$$m_s^2 \sim -\frac{|\lambda|^2}{(4\pi)^2} (6\tilde{m}_D^2 + 4\tilde{m}_L^2) \log \frac{M_{\text{mess}}^2}{m_Y^2}$$

$$W = \lambda SY\bar{Y} + m_S S^2 + m_Y^2 Y\bar{Y}$$

$SY\bar{Y}$	
$m = 100 \text{ GeV}$	$m_{\tilde{s}} = 100 \text{ GeV}$
$\lambda = 0.2$	$m_{s,a} = 91 \text{ GeV}$
$m_Y = 1000 \text{ GeV}$	$\Gamma_{s,a} = 2 \times 10^{-7} \text{ GeV}$
$\tilde{m}_D = 300 \text{ GeV} \quad \tilde{m}_L = 200 \text{ GeV}$	$\text{Br}_{s,a \rightarrow \gamma\gamma} = 4 \times 10^{-3}$
$M_{\text{mess}} = 100 \text{ TeV}$	

$$\lambda \lesssim 0.1 - 0.2 \quad \delta m \lesssim 10 \text{ GeV}$$

 Integrating out “messengers” Y ’s,

 Portal in $\lambda^a \sigma_{\mu\nu} G^{a\mu\nu} \psi_S$

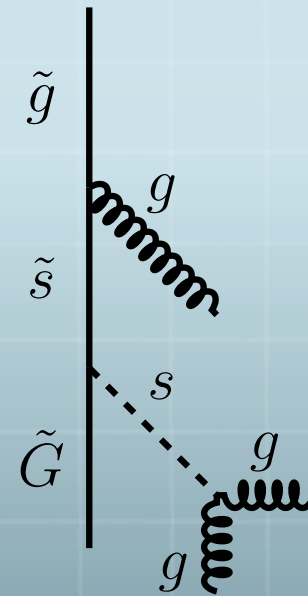
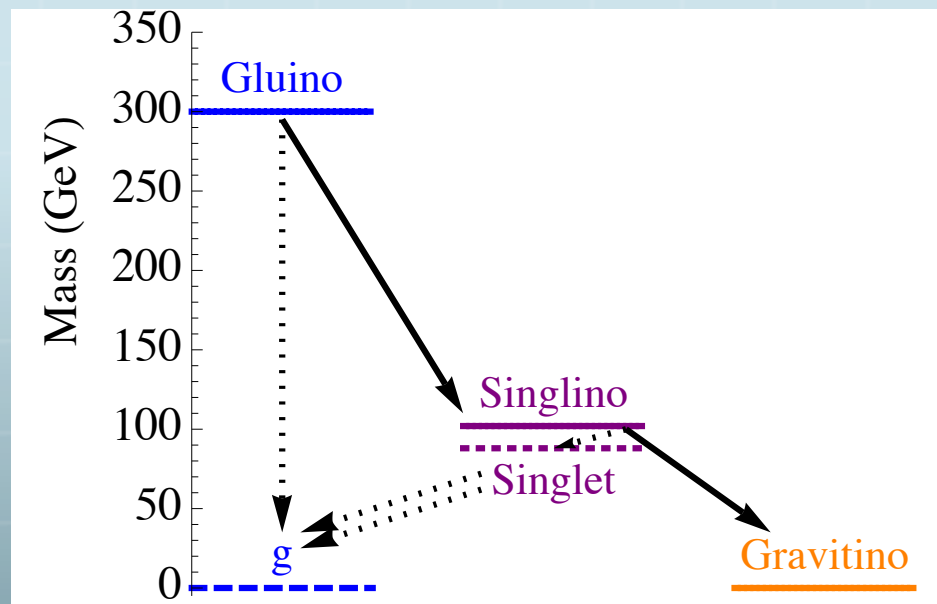
$$\tilde{g} \rightarrow g + \psi_S$$

$$\tilde{B} \rightarrow \gamma + \psi_S$$

 Portal out $s G_{\mu\nu}^a G^{a\mu\nu}$

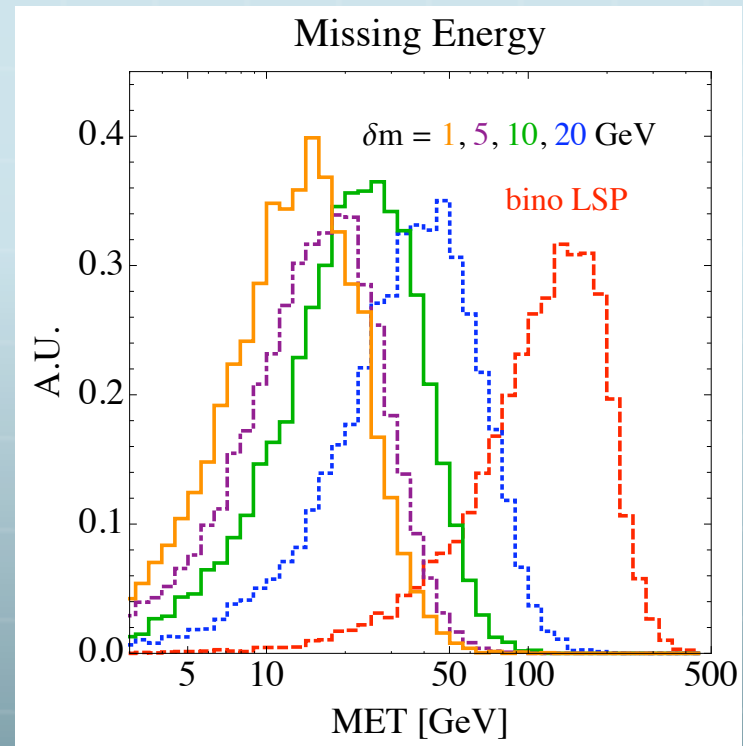
$$s \rightarrow gg$$

Spectrum and decay chain

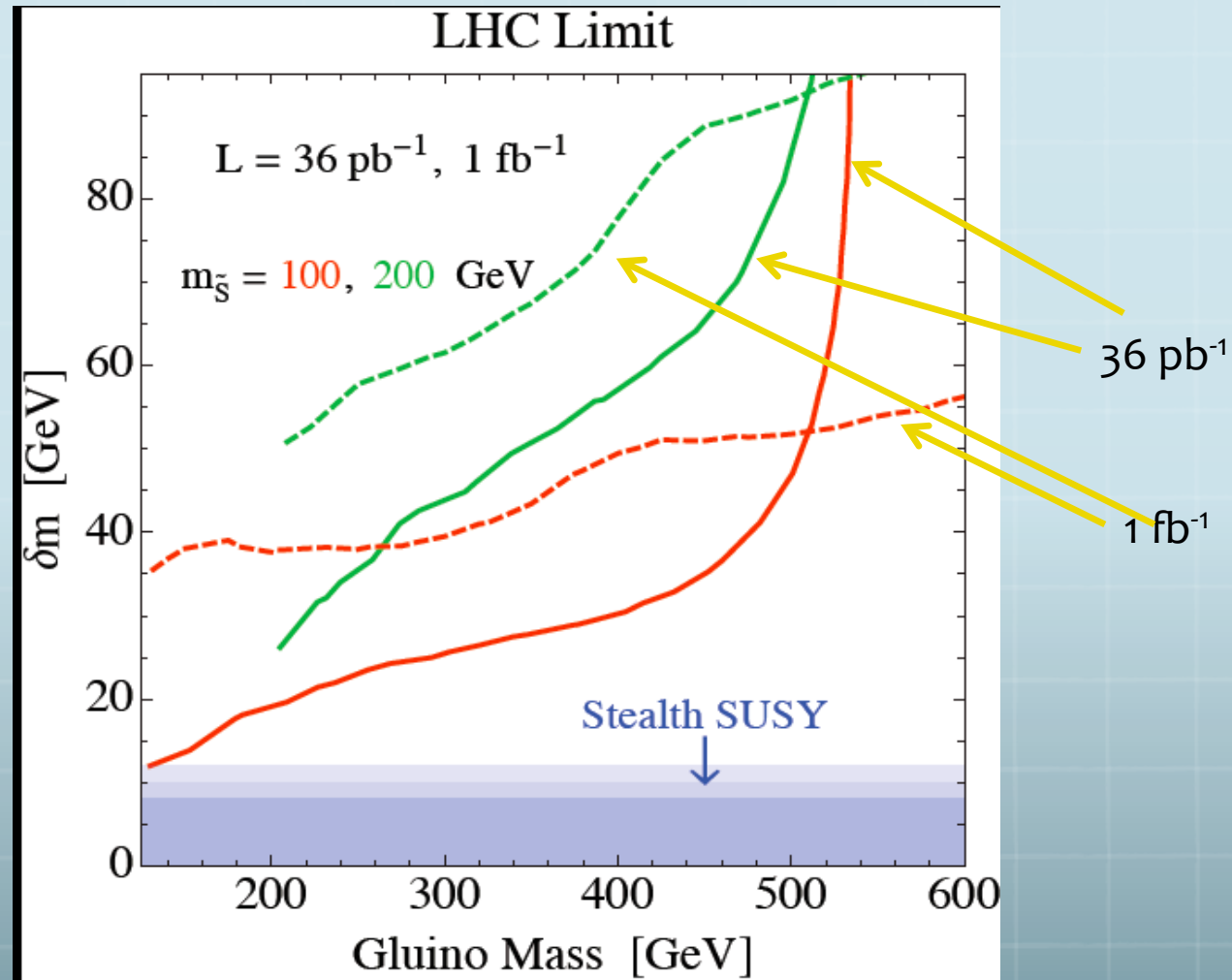




Missing energy spectrum



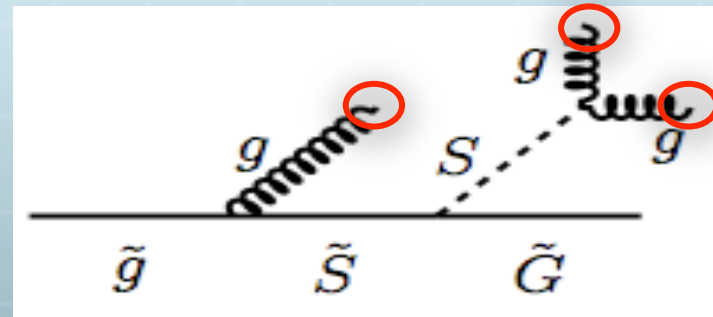
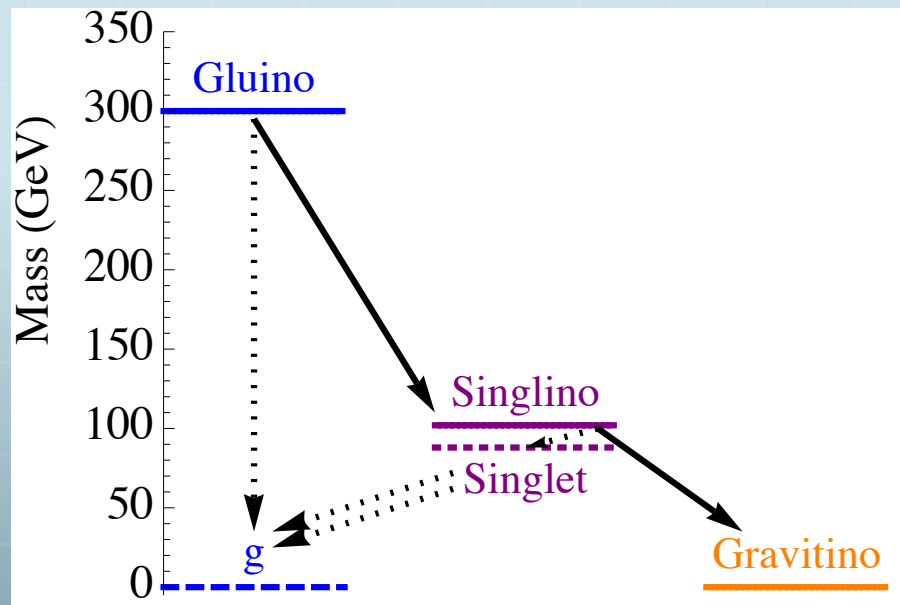
Missing $E_T > 130$ GeV, ATLAS



Bottom line:

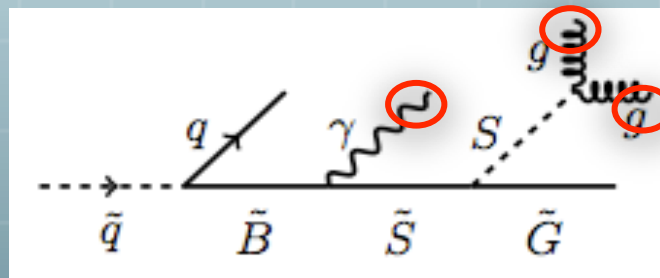
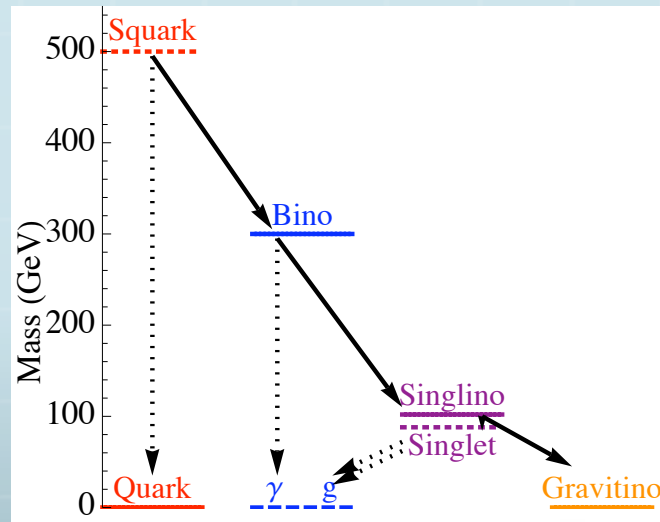
current limits do not apply to stealth SUSY with mass splitting smaller than 10 GeV !

False resonance of jets



Search at CDF and CMS motivated by RPV on resonance of 3 jets also applies here!

False resonance of jets



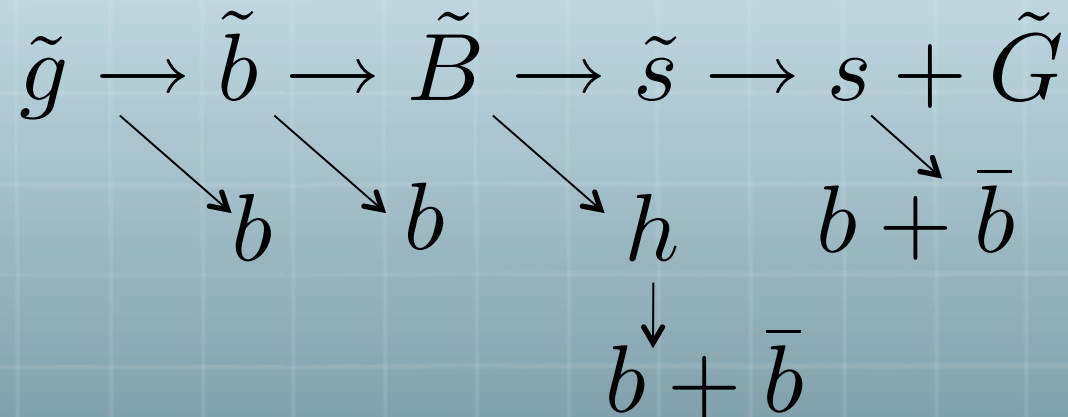
Search at CDF and CMS motivated by RPV on resonance of 3 jets also applies here!

More searching strategies

- Displaced vertex: $\tilde{s} \rightarrow s + \tilde{G}$



Decay length ranging from mm to several cm;

- High multiplicity (of b jets): Model dependent



In model where S mixes with SM Higgs: $SH_u H_d$

Conclusion

-  We present a broad class of natural supersymmetric models that preserve R-parity but lack missing energy signatures.
-  The main feature is the presence of nearly degenerate fermion-boson pairs at the electroweak scale due to an approximate supersymmetry.

Even MSSM may have a form of stealth supersymmetry, if the right handed stop and top have nearly degenerate masses.

-  It opens up more possibilities for model building and searching strategies at the LHC.

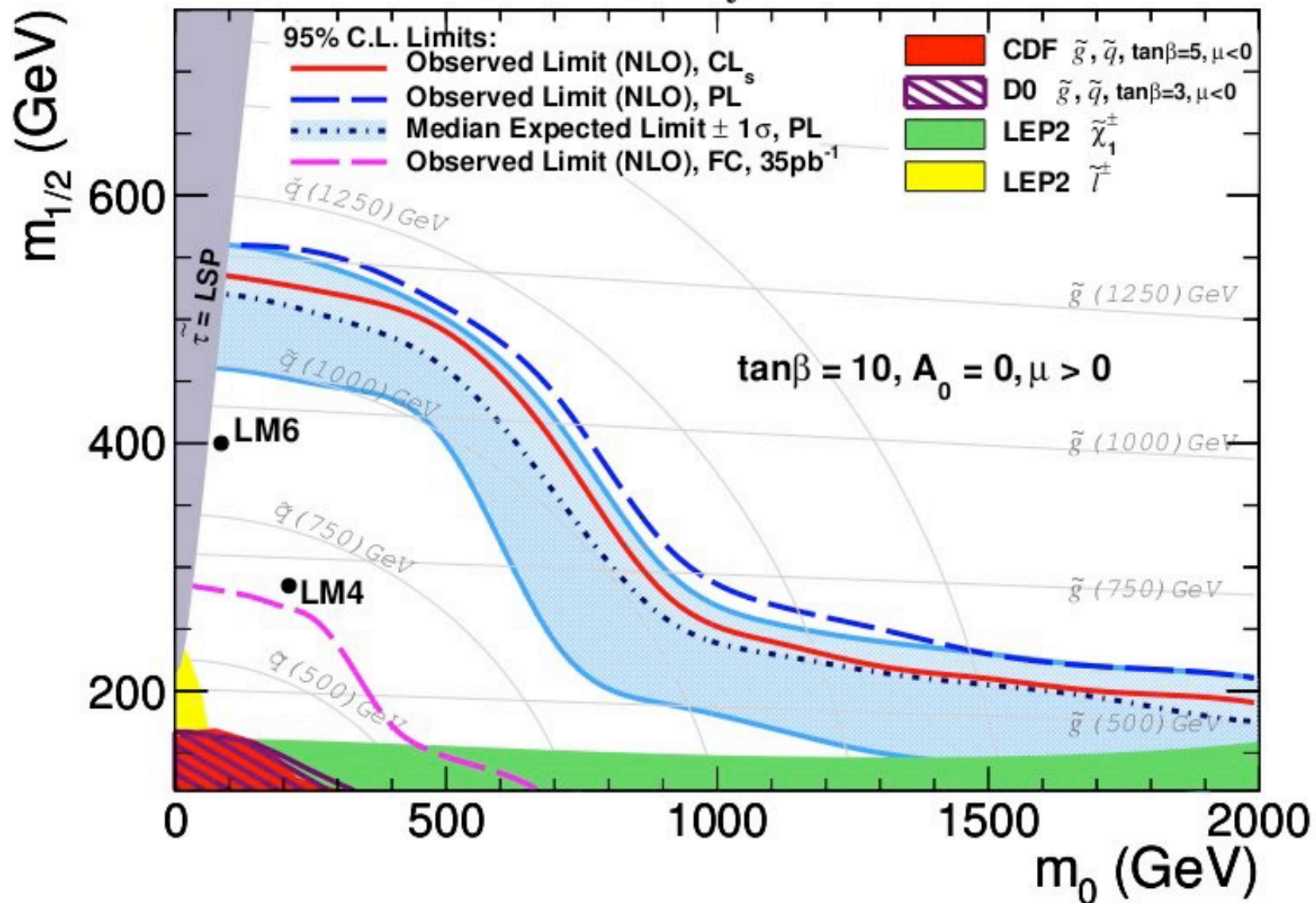
Thank you!

Backups

CMS preliminary

α_T

$\int L dt = 1.1 \text{ fb}^{-1}$ $\sqrt{s} = 7 \text{ TeV}$



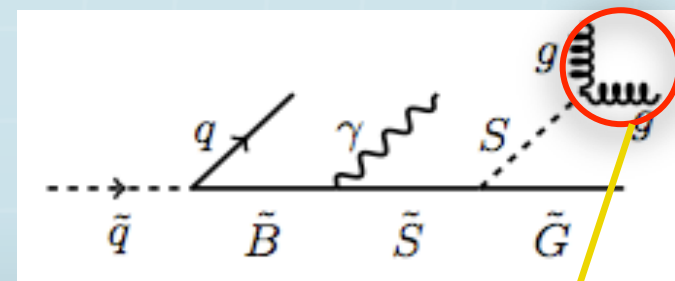
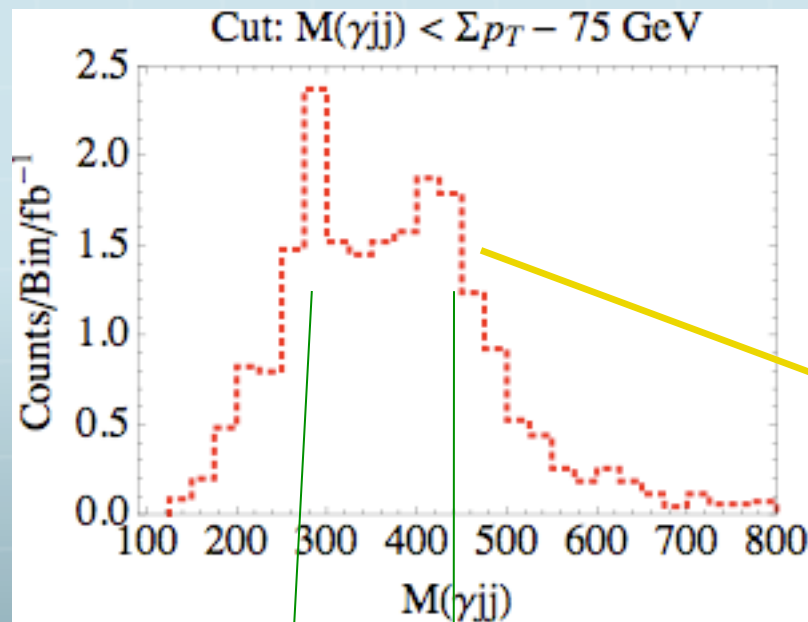
- A simple and natural exception: SUSY without MET
- A EW scale hidden sector with a squeezed spectrum
- **Simplest possibility: a chiral superfield S**



$$m_S \sim \mathcal{O}(100 \text{ GeV})$$

$$\delta m \sim \epsilon m_{EW} \sim \mathcal{O}(10 \text{ GeV})$$

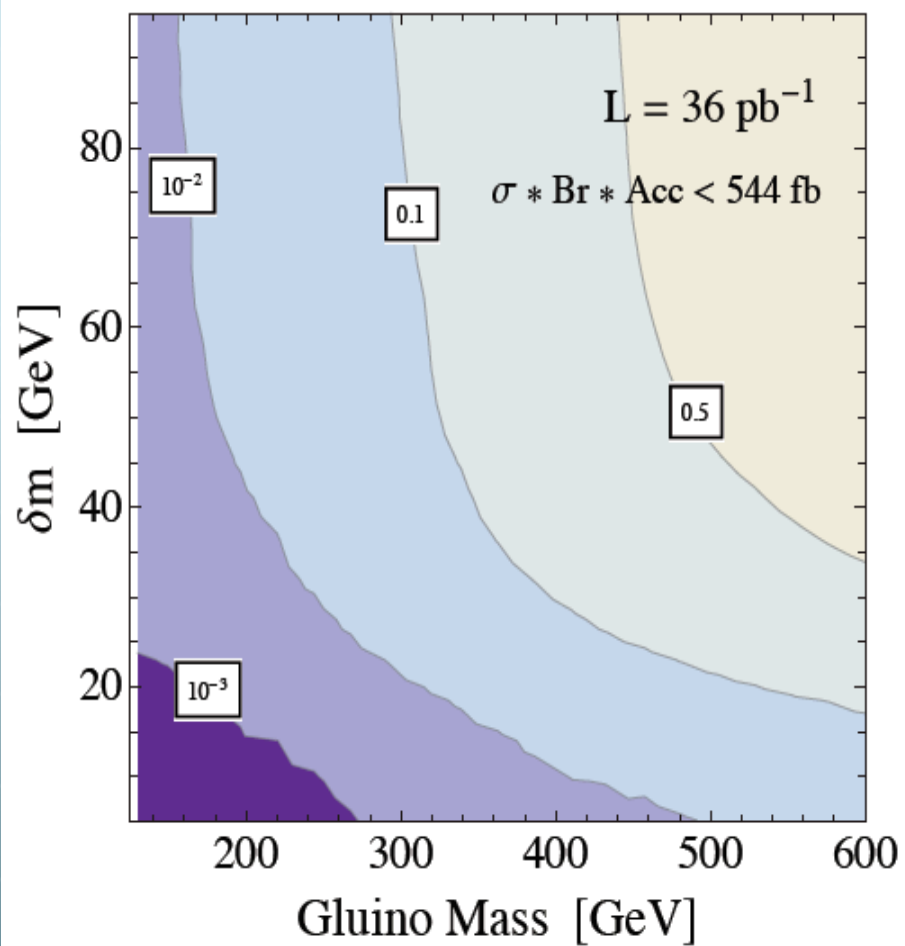
Small splitting inside the hidden sector could come from SUSY breaking transmitted through SM Higgs portal or additional EW scale SM charged messengers



Two jets collimated into one

Substructure could help!

Acceptance 2010



Acceptance 2011

